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An Outstanding Problem of Meteorology

By D. BRUNT, M.A.

AMONG the outstanding problems of physical meteorology none is more puzzling than that offered by the phenomena grouped under the name of "convection." In the *Meteorological Glossary* under the heading of convection, we find the following: "In general, if a part of a fluid, whether liquid or gaseous, is warmed, its volume is increased, and the weight per unit of volume is less than before. The warmed part therefore rises, and its place is taken by fresh fluid which is warmed in turn." This statement in essentially the same form is to be found in any text-book of meteorology. From this statement is developed the law of statical equilibrium in the vertical, which states that a mass of air is stable if the potential temperature increases with height, and unstable if the potential temperature diminishes with height. Thus the limiting condition between stability and instability is that potential temperature should remain constant at all heights, or, in terms of temperature, that the lapse rate should equal the adiabatic. A lapse rate less than the adiabatic should give a stable atmosphere, and a lapse rate greater than the adiabatic an unstable one.

The derivation of these conditions of stability from the assumptions made, is simple and straightforward, and offers no difficulty even to the humblest mathematician. Difficulties only begin to arise when we compare the theory with the actual

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phenomena. We then find, not that air rises as soon as it is heated, but that on the contrary air can be heated in its lowest layers until the lapse rate may be twenty or even thirty times the dry adiabatic, and that this state can persist for considerable periods of time, even in air which is not still. We are thus forced to the conclusion that convection, such as we have been led to expect, does not occur as readily in the atmosphere as the simple theory demands.

There is a further complication too. We should expect that if, starting with a lapse rate greatly in excess of the adiabatic, there was a violent upheaval of the conditions, due to the ascent of air from the ground, the result should be to bring down to the ground the air with the lowest potential temperature, and that the final result should be to yield a system with potential temperature increasing or constant with height. But there is a suspicion, partly based on observation, that the result of the upheaval is frequently to leave the system with potential temperature decreasing with height, and therefore still unstable, judging stability by the criterion of the first paragraph.

It is thus clear that the phenomena observed in the atmosphere (and they can be observed on any sunny afternoon), do not fit in with the simple theory of the textbooks. The question which naturally arises is—what is wrong with the theory? It can only be wrong in its assumptions. Now at first sight it might appear that the ordinary textbook theory is devoid of all assumptions. The atmosphere, however, is a compressible viscous fluid, which has a definite power of absorption and radiation, and we readily find that the theory of stability usually given makes no allowance for viscosity, or for radiation and absorption. The present writer is of opinion that the neglect of these factors is at the root of the trouble, and that the physical basis of stability in the atmosphere should follow the lines discussed by the late Lord Rayleigh in his treatment of convection in an incompressible conducting fluid*. An outline in brief of the underlying ideas involved in the application of Rayleigh's method to the atmosphere was given by the present writer, in this magazine for February, 1925, and in *Nature* for February 28th, 1925. The problem has not been solved in the meantime, and the attention of meteorologists is invited to the points of difficulty involved.

It appears to be fairly certain that the effects of radiation and absorption in damping out small irregularities of temperature must be an important factor in the maintenance of the very large lapse rates which are so frequently observed. The importance of radiation in the lower layers of the atmosphere was very strongly emphasised in a recent paper read by Prof. Chapman before the

* See *Phil. Mag. XXXII.* (1916), 529.

Royal Meteorological Society. In that paper Chapman explained the fact that the temperature at the top of the Eiffel Tower begins to rise during the morning long before the lapse rate has reached the adiabatic, by ascribing to radiation and absorption a far more important rôle than has hitherto been assigned to them. The weakness of the treatment given in that paper lay in the rather uncertain nature of the observations discussed, and it is highly desirable that reliable observations of temperature at different heights should be obtained by means of delicate self-recording instruments. Chapman's paper marks a very definite advance in that it shows that convection and turbulence do not in themselves account for the phenomena observed, and it strengthens one's feeling that the effects of radiation and absorption are very closely bound up with the effects of convective turbulence. If the effects of these phenomena could be separated, we should then have a clearer idea of the time scale of radiation effects. The time scale of radiation effects is a matter concerning which our knowledge is very hazy. The present writer, at any rate, knows of no clear statement of it. It does not of course follow automatically that the time scale of radiation effects would be the same at the tropopause as it is at the ground, but it might be possible to extrapolate without violation to commonsense.

The greatest of all problems in meteorology is closely bound up with the time scale of radiation effects—the greatest problem referred to being the maintenance of the general circulation of the atmosphere. It can be shown that the amount of energy of the general circulation which is dissipated by turbulence could be replaced if 2 per cent. of the incoming solar radiation were converted into kinetic energy. It has been suggested by Sir Napier Shaw* that the transference of solar energy into kinetic energy is in part brought about through the ascent of warm humid air within the tropics, the ascended air moving polewards in the upper air, but on account of cooling by radiation descending in middle latitudes, after which it completes a cycle by moving equatorwards over the earth's surface. To this it has been objected that the horizontal stratification of the atmosphere is such as to oppose descent of air from above. But it appears possible that the poleward moving air is cooled by radiation sufficiently rapidly to be able to descend, being, as to temperature, a normal sample of the air at each successive level during its descent. To answer the question raised here, it is thus necessary to determine the time scale of radiation effects.

It is customary to think of ascending currents as being much more violent than descending currents, the latter being spread over a wider horizontal area, and therefore demanding smaller

* Dictionary of Applied Physics, Vol. III. p. 82.

velocities in the vertical. Cases have been observed, however, of the descent of artificial clouds at a rate of the order of 1,000 feet per minute, or about 5 metres per second. It would be illuminating to have a mental picture of the physical or dynamical processes involved in these large descending currents.

There is another problem of meteorology which may be closely associated with convection, namely, the initial stage of formation of a cyclonic centre. The diagrams given by J. Bjerknes and Solberg to illustrate the stages of development of a cyclone show as the initial stage the bulging of the warm air into the cold air. This raises a rather intriguing point, in that the process suggested appears to require the pushing back of the cold air, and therefore a slight increase of potential energy, which should involve a diminution of kinetic energy. But the initial stage of development of the cyclone surely involves an increase of kinetic energy. The present writer has always found this a puzzling difficulty. It may be that the solution of the difficulty lies in the assumption of a thermal centre of convection for the cyclone. The later stages of development of the cyclone do not present quite the same difficulty, since the interaction of the nascent cyclone and it surroundings would bring into play forces of the right kind to keep the cyclone in being, and to make it deepen.

The sole aim of the writer of the present note is to state as clearly as possible a difficulty which must have occurred to any serious student of meteorology—a difficulty which, moreover, concerns two of the most fundamental factors in meteorology, convection and radiation. It is certain that the solution of the problems stated above would throw light on many obscure parts of the subject. The writer has long felt that the most pressing need of modern meteorology is that someone should set down on paper the things we definitely know, and are all agreed upon. Failing that, a clear statement of the things we do not understand should be of some little value. It is of course possible that the difficulties discussed above are not difficult to some readers of the *Meteorological Magazine*. Should this prove to be the case, perhaps they will be good enough to expound their views.

OFFICIAL PUBLICATIONS

The following publications have recently been issued :—

The Weather Map. An Introduction to Modern Meteorlogy. By Sir Napier Shaw, F.R.S. (M.O. *225i*), Sixth issue.

The first edition of the *Weather Map* was published in 1916 for the benefit primarily of those who were making use of meteorology in the late war.

The book opens with a detailed account of the method of

constructing weather maps, illustrated by charts showing the distribution of the weather, winds, temperature and pressure on the same day, August 2nd, 1915. The sequence of weather and its classification according to a few simple types of pressure distribution are next dealt with, two examples being given of the effect of notable cyclonic depressions which have passed over the British Isles, illustrated by a series of maps. The upper air and the conditions prevailing there are then described. As a supplement, climatic summaries are given for London, Paris, Balkan Peninsula, Mesopotamia, Egypt and East Africa, as representing the types of climate in the various theatres of war, together with a series of isopleth diagrams of the mean temperature, pressure, wind, rainfall and humidity at the four observatories of the Meteorological Office. The climate of the British Isles is further illustrated by charts showing the normal distribution in January and July of day and night temperatures, bright sunshine and rainfall.

PROFESSIONAL NOTES—

No. 42. *The Investigation of the Winds in the Upper Air from Information regarding the place of Fall of Pilot Balloons and the Distribution of Pressure.* By J. Durward, M.A. (M.O. 273*b*).

This note discusses the horizontal movements of pilot balloons in relation to the distribution of pressure. The data used are obtained from post cards, on which the date, place and time of origin are entered, attached to the pilot balloons. These balloons are released three or four times a day at many stations and the finder is requested to return the card after entering the place and time of finding. During 1923 over 1,000 cards were returned.

The results of this investigation throw a certain amount of light on the direction of winds at high levels, especially in a few instances in which the balloons travelled at high speeds for great distances, but the method is attended by so many uncertainties that it is on the whole inferior to the careful observation of high clouds. On the other hand it is practicable in all weathers.

Discussions at the Meteorological Office

November 9th, 1925. *The light of the night sky, its intensity variations when analysed by colour filters.* By Lord Rayleigh (London, Proc.R.Soc., A. 106, 1924, pp. 117-137, and A. 109, 1925, pp. 428-444). *Opener*—Dr. G. M. B. Dobson.

In recent years Lord Rayleigh has made a special study of the light received from the night sky. The essential feature of this light is its comparative redness, there being about ten times as much red colour relatively to the blue as in the twilight sky.

It is therefore not atmospherically diffused sunlight; possible explanations are that it is sunlight scattered by cosmical dust, and that it is due to light from stars individually indistinguishable. The light is too feeble for ordinary spectrographic work, but after using a preliminary apparatus Rayleigh was able to construct a spectrograph working at F/1·8 and later one of F/0·9. The main feature of the spectrum is the green auroral line which can be photographed on most nights, though its intensity is variable. Rayleigh proposes to call this permanent aurora, the non-polar aurora. A faint continuous spectrum showing dark lines is present, and two new bright lines in the violet (4200 Å and 4430 Å) were found. It was at first thought that the intensity of the non-polar aurora increased with distance from the pole, but this is probably not the case. Rayleigh favours the theory that the light is of phosphorescent origin in the upper atmosphere. The light is not polarised, and there is no simple relation to magnetic character or the number of sunspots.

Dr. Simpson stated that in Norway it was possible to detect the green line when a black cloth, situated at a little distance from the observer, was viewed spectroscopically. Messrs. Knox-Shaw and Bonacina mentioned the obvious variations in the visual intensity of the general light of the night sky. Other interesting points were brought out in the discussion, including the possible sources of error in the investigations.

November 23rd, 1925. *The Kalahari Project.* By E. H. L. Schwarz (Matériaux pour l'étude des calamités, 1. (1925), pp. 291-332). *Opener*—Mr. C. W. Lamb, B.Sc. (see page 262).

The subject for discussion for the next meeting, on Monday, January 18th, will be two papers by W. Wiese:—

Polareis und atmosphärische Schwankungen (Geog. Ann. Stockholm VI, 1924, pp. 273-299), and *Die Einwirkung der mittleren Lufttemperatur im Frühling in Nord-Island auf die mittlere Lufttemperatur des nachfolgenden Winters in Europa* (Met. Zs. 42, 1925, pp. 53-57). *Opener*—Sir Gilbert Walker, C.S.I., F.R.S.

Royal Meteorological Society

On November 11th Dr. C. G. Abbot, honorary member, director of the Astrophysical Observatory, Washington, and secretary of the Smithsonian Institution, delivered a popular lecture on "Measuring the Sun's Rays." The subject matter of the lecture was dealt with in the article entitled "Weather Forecasting with the Help of the Sun," which appeared in the *Meteorological Magazine* for November, 1925, p. 237. The Smithsonian

Institution is now trying to improve the solar radiation observations. The two stations in Arizona and Chile are not sufficient, and on many days no observations are obtained. The National Geographical Society of the United States has made a grant to establish a third solar radiation station in the eastern hemisphere. The requirements are a stable government, ready means of communication, cloudless skies, and a high altitude, and Dr. Abbot is now on his way to examine possible localities in south-west Algeria, north-east Baluchistan, and south-west Africa.

The first of the regular monthly meetings of the Society during the present session was held on Wednesday, November 18th, at 49, Cromwell Road, South Kensington, Capt. C. J. P. Cave, M.A., President, in the Chair.

Sir Gilbert Walker, C.S.I., F.R.S., and E. W. Bliss, M.A.—On correlation coefficients: their calculation and use.

This paper dealt mainly with practical considerations. By employing as a unit for each variant to be correlated the standard deviation divided by $\sqrt{20}$, a considerable saving of time can be effected. Calculations were also given of the likelihood that with any given coefficient the forecasted and the actual departures will have the same sign, and also of the frequency with which it would be possible to make a forecast with a 4 : 1 chance in its favour. Finally, an example was given of the danger of working with differences from one year to another unless special precautions were taken. In the discussions some instances were given in which the use of such differences led to useful results.

C. O. Stevens—Note on the variations in transparency of the atmosphere observed by means of a projected telescopic image of the sun.

When an image of the sun is projected into a darkened room through a non-achromatic telescope, prismatic colours are seen on the screen, and these give information as to the condition of the atmosphere. A predominance of green is especially indicative of rain. In the discussion it was pointed out that the same principle was utilised in the old "rain-band" spectroscope.

N. L. Silvester, M.Sc.—Notes on the behaviour of certain plants in relation to the Weather.

An investigation was made to test the local forecast value of plants reputed in weather-lore to give predictions by movements in their flowers or leaves. The analysis of 1,300 observations upon pimpernel, daisy, chickweed, clover, dandelion, marigold and gentian gave negative results. Temperature of the soil surrounding the roots proves to be a control factor in the movements of daisy and chickweed. Above the critical temperature in these two plants and in the pimpernel, relative humidity becomes the dominant factor, a value of approximately 80 per cent. being the critical maximum. Clover leaves respond to

wind velocity. The closing movement commences when the velocity at 42 ft. above the surface exceeds 20 m.p.h. Those plants that respond to relative humidity can thus be used for prediction of rain only in so far as its incidence is preceded by the required humidity, and they are unreliable as local weather forecasters. These conclusions refer only to the irregular day movements. The cause of the regular movements near sunrise and sunset has not been solved by this investigation.

Correspondence

To the Editor, *The Meteorological Magazine*

Ground Horizontal Visibility and Convection

THE investigation into the relationship between upward convection currents and ground horizontal visibility at 13 h. at Cranwell, Lincolnshire, which was described in the *Meteorological Magazine* for April, 1924, p. 63, has now been continued over a total of six summers, 1920-1925 inclusive.

As before, the criterion for the presence of convection currents upward was taken to be the presence of cumulus or cumulonimbus at or within the neighbourhood of 13 h.

The results obtained are shown in the accompanying table and justify further the conclusion previously arrived at, that convection days are more likely to be accompanied by good visibility, that is a visibility of 13 miles or more, than are non-convection days, and are very unlikely, indeed, to be accompanied by poor visibility, that is a visibility of less than $2\frac{1}{4}$ miles.

Cumulus or Cumulo-Nimbus at or about 13 h.	Total No. of Observations.	Ground Horizontal Visibility at 13 h.					
		13 miles or more		$2\frac{1}{4}$ miles or more, but not reaching 13 miles.		Less than $2\frac{1}{4}$ miles	
		Total No.	Per cent.	Total No.	Per cent.	Total No.	Per cent.
Present ..	756	369	48·8	386	51·1	1	0·1
Absent ..	342	84	24·6	245	71·6	13	3·8

WILLIAM H. PICK.

R.A.F. Cadet College, Cranwell, Lincolnshire. September 30th, 1925

Winter Thunderstorms

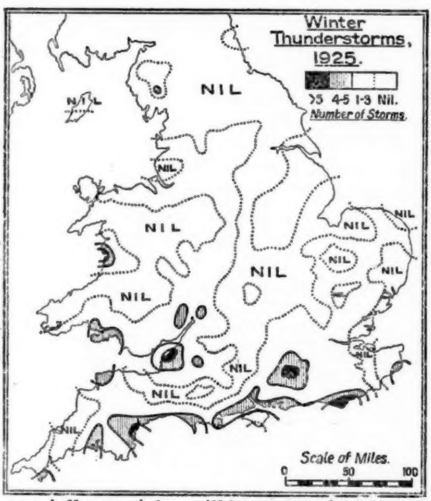
AN appeal was made in December, 1924, to readers of the *Meteorological Magazine* for reports of thunder or lightning occurring during the first three months of this year. I should like to thank very sincerely the large number of observers who supplied information.

Thunderstorms occurred somewhere in the British Isles

between January 1st and March 31st, 1925 (both dates inclusive), on 57 days. The following table shows the number of days for each country :—

1925.	England and Wales.	Scotland.	Ireland.	British Isles.
January	10	12	10	17
February	20	10	8	23
March	16	5	4	17
Total ...	46	27	22	57

The distribution of the thunderstorms in England is shown on the accompanying map. In Scotland there was scarcely more than one storm in any of the eastern or southern counties; but on the west coasts of Ross, Inverness and Argyll, and in the Western Islands, storms were particularly frequent.



It is hoped to continue the investigation during this winter, and I shall, therefore, be very glad to receive reports of thunderstorms in any part of the British Islands, especially in Scotland or Ireland, between January 1st and March 31st, 1926, inclusive. A note on a post card of the date and time of the occurrence of thunder or lightning, with the direction in which the lightning was seen, especially at night, will be very valuable. Any additional information of the following character will be extremely welcome :—

1. The time when the storm passed overhead or was nearest, with its direction; and how long it lasted.
2. An estimate of the severity of the storm.
3. Whether it was accompanied by rain, hail or snow.
4. Direction and strength of wind; change of wind (if any).
5. Whether there was a change in temperature during the storm.
6. Any other observation which may be of particular moment.

It is particularly asked that the position of the place of observa-

tion should be indicated by mentioning the estimated distance and direction from the nearest town. A note that no thunder or lightning has been observed will be useful.

S. MORRIS BOWER.

Langley Terrace, Oakes, Huddersfield. November 3rd, 1925.

Crepuscular Rays

I WAS interested to read Mr. Knight's letter on Crepuscular Rays in the September issue. I saw a similar phenomenon on the evening of May 18th, 1924, at Wadhurst (Sussex). A few minutes after sunset I observed two well-defined luminous rays converging to a point on the south-east horizon. The sky was mainly clear, but with fine, detached cumulo-nimbus cloud in places. Two of these clouds were towards the south-east horizon, but the rays had no apparent relation to their forms.

On July 5th, 1911, Mr. G. A. Clarke of Aberdeen saw a system of eight bright rays converging to the south-east point at sunset (20 h. 55 m.). On this occasion the sky was cloudless, save for a low bank of cloud in the north-west, which covered the sun. The rays were seen right to the horizon.

The phenomenon is referred to in Humphrey's *Physics of the Air*, under the heading of "Crepuscular Rays," and is there stated to be of precisely the same origin as the well-known rays seen when the sun is behind a cloud ("sun drawing water"). Doubtless, however, the convergent rays in the south-east at sunset are much less frequently observed. Mr. Knight speaks only of dark rays, while Mr. Clarke shows only bright rays in his sketch. In my own observation each bright ray had its attendant dark one. Humphrey's explanation is that streaks or bands of pearly light are seen when the lower atmosphere is illuminated, and azure shadows when only the upper atmosphere is illuminated.

E. W. BARLOW.

October 7th, 1925.

NOTES AND QUERIES

Drought, Its Prevention and Cure

AN article* by Professor E. H. L. Schwarz, well-known for his proposals to increase the rainfall of South Africa by reconstituting the ancient lakes of the Kalahari region, was the subject of an interesting discussion at the Meteorological Office. There are several areas, such as the "Great Basin" of North America and the Lop Nor depression of Central Asia, in which a relatively low-

* The Kalahari project. Matériaux pour l'étude des calamités, Vol. I., No. 4, 1925. Genève, Soc. de Géographie.

lying central area is surrounded on all sides by higher ground. These basins formerly contained extensive lakes of which there are now only small remnants. Professor Schwarz considers that the large lakes of antiquity were maintained by "internal circulatory systems," in which the water evaporated from the lakes is condensed on the mountainous side-walls and runs back into the basin, the small amount of moisture which crosses the mountains on one side being made good by a corresponding inflow of moist air on the other side; consequently there is no loss of water. As soon as the balance is destroyed by the diversion of any of the water, however, the internal circulatory system breaks down and there is rapid and extensive desiccation. The circulatory system in various stages of decay is well-shown in Africa. "We may divide Africa into three sections; the north, where the internal circulatory system has disappeared, and most of the country is desert—the Sahara; the central districts, where the great lakes maintain the internal circulatory system and where things are normal; South Africa where the central lakes have recently dried up, and where a disaster of the first magnitude is threatened unless something is done." The Sahara formerly contained an inland sea—the "African Caspian"—with an area of 150,000 square miles, which was supplied by the northward flowing Joliba, but a coastal river cut through the hills and intercepted the Joliba to form the Niger, and the "African Caspian" dwindled to Lake Chad. Even the rivers which maintain this miserable remnant are now in danger of interception, promising a further catastrophe. In Central Africa the great lakes still function as sources of rain for the interior, but there is imminent danger that Lake Victoria will be drained into Tanganyika, with disaster to the whole Nile Valley. In South Africa the water supply to the Kalahari lakes has been intercepted by the Cunene and the Zambesi, the latter breaking through the Victoria Falls probably about 500 years ago.

The facts of river piracy are well known, and the geographical changes adduced are possible and even probable. It is conceivable that human ingenuity could reverse the process and divert all the rivers into the interior so that not a drop of the precious fluid ran waste into the sea; that is a question for engineers. Perhaps this stage has already been reached on Mars, but the author does not propose anything on the Martian scale; he proposes to divert the waters of the Okavango, Chobe and Cunene rivers, the water so obtained to be used for irrigation, and only the surplus to go towards reconstructing the lost lakes. The part of his argument which concerns meteorologists is that which deals with the automatic increase of rainfall following on this diversion. "To restore South Africa to fertility, we

require an additional 10 inches of rain, which spread over the million square miles is 23 billion cubic feet. To give this, we propose to impound the waters of the three rivers " whose total discharge is 2½ billion cubic feet. " If all this water is annually added to the general stock of the country and retained in it by reason of its peculiar basin-shaped structure, *then in ten years, with the scheme in full working order, we shall obtain the requisite additional rainfall.*" The italics are our own. But here one is entitled to ask a simple question. If the rainfall increases by ten inches a year in ten years, what will happen after the ten years have passed? Will the rainfall continue to increase annually by one inch, until the country is drowned out, or is it proposed to cut off the supply of water and allow the " internal circulatory system " to continue to function without external aid? Or is there some peculiar virtue in the ten-year limit which we have overlooked? The whole question depends on the extent to which water evaporated from the proposed lakes will be again precipitated within the basin. There are several " basins " in different parts of the world into which rivers pour water, while there is no visible outflow, and in all of these the outgoing air must carry more water vapour than the incoming air. Hence, if more water is turned into the Kalahari, we should expect the outgoing air to contain more water vapour. Part of the water evaporated from the reconstituted lakes would no doubt be again condensed within the basin, but only part, and although some water might fall as rain twice over, it does not seem probable that the increased rainfall would exceed the evaporation from the lake. The author proposes to form a lake with an area of 20,000 square miles, the annual evaporation being estimated as 90 inches a year and the total area of the basin being about a million square miles. If all the evaporated water were condensed once within the basin, the average annual rainfall would be increased by about two inches, but until the experiment has actually been tried no one can say definitely what would happen.

During the past fifty years, meteorologists have realised that their science cannot be treated on a parochial or even on a continental basis; the world is one complex whole, and the climatic variations of its different parts are inter-related according to some plan which we are only now dimly beginning to guess. South Africa is drying up, but if the process of desiccation is really due to decreased rainfall, which is not yet proved, the first step is to determine whether the decrease cannot be correlated with general changes in the meteorological situation. The author quotes figures which point to an average decrease of about one inch per annum in the rainfall between the periods 1881 to 1900 and 1901 to 1920. But when we turn to north-west

Africa we find at Bathurst a decrease of nine inches per annum during the same period, and at Sierra Leone a decrease of 25 inches per annum, and both these places are on the seaward side of the rim. Even in the Cape Verde islands, in the open ocean, the rainfall has suffered a marked decrease. These facts suggest that the disappearance of the Kalahari lakes is part of some more general change, on so vast a scale that human endeavour can perhaps palliate but cannot hope to reverse it.

Tapered Rain Measures

UNDER the heading "A New Rain Measure," a description was given in the issue of the *Meteorological Magazine* for September, 1924, of a new type of rain measure which had been adopted by the Meteorological Office. For a time, difficulty was experienced in obtaining supplies of these measures, and on this account there were, in some cases, unfortunate delays in supplying observers who wished to get the new pattern measures. Manufacturing difficulties have, however, been overcome, and supplies are now available at the Meteorological Office for issue to rainfall observers.

For the 5-inch measure graduated in inches and the 8-inch measure graduated in millimetres, it has been possible to effect an appreciable reduction in the price. The former size measure can now be supplied to observers for the Office at a price of 3s. 9d., and the latter at a price of 4s. 7½d. if collected at the Meteorological Office, South Kensington. Additional charges are involved for the packing box and postage if the measures are despatched by post.

Errors in Sunshine Spheres
Preliminary Note

ACCORDING to the specification adopted by the Meteorological Office the focal length of the glass spheres used in the standard pattern Campbell-Stokes sunshine recorder must be 2·95 inches. Some investigations have recently been made for the purpose of determining to what extent the record is affected by errors in this focal length and also by the presence of striations in the glass which may affect the definition of the image formed by the sphere.

The results obtained indicate that if the focal length is too great by a few hundredths of an inch the burning power of the lens is not affected. On the other hand, if the focal length is too short so that the focus comes between the card and the sphere, the record of sunshine may be very seriously affected. The presence of striations does not appear to produce serious effects provided that the focal length is correct.

In a future article details will be given of the results obtained, together with a description of the apparatus now in use at the Meteorological Office for the accurate measurement of focal lengths.

Atmospheric Electricity: The meteorological significance of atmospherics over the sea

It was recognised in the early days of wireless telegraphy that "atmospherics" had some connection with meteorological phenomena and might be made use of in weather prediction. Investigations were made in England during and after the war but they did not lead to any positive results which could be put to practical use.

From a note by Captain R. Bureau (of the National Meteorological Office of France) and M. Covecque, published in the *Comptes Rendus* of the Academy of Science in April last, there appears to be a better prospect of making use of " atmospherics " on board ship. The note is based on observations made on the French ship *Jacques-Cartier* and is made interesting by the fact that the observations of " atmospherics " could be related to the distribution of meteorological elements over the ocean collected simultaneously by wireless reports from other ships. The authors arrived at the conclusion that the approach of a " cold front " (of the Bjerknes Theory) is preceded by the appearance of atmospherics whose intensity increases up to the passage of the front across the ship. The atmospherics begin about 250 miles away from the front by day and 400 miles away by night, and usually after the passage of the front there is a temporary decrease in atmospherics. The atmospherics recommence again in the polar air associated with the rising barometer in the rear of a depression. Atmospherics disappear as a rule when an area of falling barometer (or a warm front) is approaching.

The phenomena mentioned are found, not only in temperate latitudes, but also in low latitudes. Atmospherics there depend in general on the perturbations of the polar front. The tropical air of the warm centres of depressions, even when they are very far south, is accompanied by no atmospherics. The authors state that atmospherics are the phenomena which show most clearly the passage of meteorological disturbances in tropical regions. Other meteorological elements such as pressure, temperature, wind and humidity, indicate the passage of such disturbances in a much less regular manner, and these elements, moreover, only indicate the disturbance at the time when it reaches the place of observation. Atmospherics, on the other hand, announce it several hours in advance.

If these conclusions of the French meteorologists are corroborated by further investigations, ships in waters less frequented

than those of the North Atlantic will have at their disposal an extremely valuable supplement to their own local observations, even when they are unable to get any meteorological observations from other ships.

Meteorological Demonstration at Chester

In response to a request from the Chester Scientific Society, a Meteorological Demonstration was given at the Annual Conversazione held in the Chester Town Hall on October 8th, 1925.

A general exhibit was arranged, consisting of synoptic charts, showing the various types of pressure distribution, with special reference to local weather conditions, and a selection of cloud photographs and upper air temperature diagrams, together with recording instruments, were displayed. A wireless receiver was installed for the purpose of obtaining the evening synoptic reports from British and Continental stations, thus making it possible to give a practical demonstration of general forecast work. The evening Shipping Inference was also received and displayed, together with a detailed local forecast for the following day.

During the evening explanations were given concerning the application of meteorology to aerial navigation, shipping, agriculture, &c., special reference being made to recent work in connexion with upper air investigation.

Great interest was shown in the various branches of the work, and all members of the Sealand Meteorological Staff were fully occupied in answering the numerous questions. Some 600 people visited the demonstration, and it is evident, from the enthusiasm shown, that there is considerable scope for further work of a similar nature.

H. F. Jackson.

Trees and Climatic Zones

An article by Henry I. Baldwin in the *Bulletin of the American Meteorological Society* for July, 1925, describes the results of experiments in planting forests with seed from different regions. It is found that seed from trees in the same climatic zone gives the best results, and that there is less risk in using seed from a region colder than the planting site than vice versa. It has been found for instance that the Scotch pine grown in Sweden from German seed forms a large percentage of crooked stems, and the importation of seeds from countries to the south has been prohibited. Sweden itself has been divided into a number of zones according to the summer temperatures, and change of more than one zone is discouraged even though the natural range of the tree is not passed.

Reviews

La Meteorologia Agraria in Italia. By D. Bernardo M. Paolini, O.S.B., La Met. Prat. Montecassino, VI., No. 3, 1925, pp. 93-107.

In this highly interesting paper the development and the present state of the relations between meteorology and agriculture in Italy are reviewed by the Director of the Observatory of the Benedictine Monastery of Montecassino, about sixty miles north-west of Naples.

The author's own practical contribution to the study of the complicated problems of agricultural meteorology is noteworthy. Beginning in 1913 with reports and studies, published in the bulletin of his observatory, on the relations between meteorological conditions and plant life, with special reference to the hill district of Montecassino and to a neighbouring locality on the plains, he was led to develop an efficient meteorological-phenological service. Towards the end of 1914, monthly reports of phenological observations on members of nine main groups of the vegetable kingdom, together with much information of a meteorological character, were being received at the Montecassino Observatory from no fewer than forty-two stations well distributed throughout Terra di Lavoro. This admirable organization, which survived the difficult years of war and continues to this day, is the immediate outcome of Dom Paolini's resolve to endeavour to apply the results of meteorological observations to the requirements of agriculture and so to stimulate interest in questions which are of fundamental importance to Italy, but which had been largely neglected for many years.

One of the earliest workers in this field in Italy was Giovanni Targioni who, in the second half of the eighteenth century, studied weather conditions in relation to agriculture in Tuscany. During the first quarter of the ensuing century Targioni's son, Ottaviano, published a number of phenological and kindred observations made in the vicinity of Florence. In subsequent years phenological or meteorological-phenological studies having more or less direct bearings on agricultural problems were carried out, somewhat intermittently, by various individuals and mainly in the northern provinces; but owing presumably to political circumstances it was not until much later in the century that any comprehensive scheme of study was attempted. In 1883, Professor Targioni Tozzetti, in conjunction with the Italian Meteorological Association, proposed the establishment in a number of suitable localities of stations where definite observations should be made of the phenomena of plant and animal life as related to meteorological conditions and other aspects of environment. Shortly after this proposal was made the Department of Agriculture, recognising the need of sustained observational work,

initiated a scheme whereby observations were to be made on a large number of species of cultivated and naturally occurring plants at thirty-eight of the observatories and stations associated with the Meteorological Office. This enterprise was extremely short-lived, for after the publication, in 1887, of the collected results of the first year's work, together with observations for several preceding years provided by Da Schio and Lampertico for sixteen stations in the Veneto and in Emilia, nothing further appears to have been done. The author thinks that the failure of the enterprise may be attributed chiefly to the excessive number of species selected for observation. On the other hand the publication, in the *Rivista Meteorico-Agraria* of the Meteorological Office, of information relating to extremes of temperature, rainfall and raindays for ten-day periods at upwards of fifty stations, together with brief reports concerning weather and crop conditions, has continued from 1879 until now.

From about the time when Paolini's efforts commenced, sundry schemes of work have been proposed from official sources. In 1912, Professor G. Azzi, of the Ministry of Agriculture, proposed the establishment in Italy of an agricultural-meteorological organization similar to the elaborate service which had been developed by Brounoff in Russia. A few years later, Azzi suggested a somewhat simplified programme, but nothing material resulted until 1921, when the Ministry of Agriculture announced the establishment of a Central Office for agricultural meteorology, associated with which were to be stations of three classes, ranging from those fully equipped with meteorological instruments to those supplying purely non-instrumental information concerning weather conditions and crops. Apparently it was intended that the new department should be independent of the Meteorological Office and that in the first instance attention should be restricted to wheat. Dom Paolini, himself a great enthusiast, admires the enthusiasm and pertinacity of Professor Azzi, but disagrees with much of the latter's policy and especially with his advocacy of an organization of the Brounoff type, which comprised elaborately equipped observatories provided with experimental fields and a numerous highly trained staff. It is urged that such a system would be impracticable in Italy, and that the creation in every Italian province of a service on the lines of that developed by the author in Terra di Lavoro would lead more readily to good results. For Paolini affirms that the best way to ensure progress is for the meteorologist to co-operate more closely with those who are directly engaged in agriculture. His most valued correspondents are the farmers themselves, who from experience and tradition have an almost intuitive, if unclassified, knowledge of the effects of the weather on crops. To put the matter briefly, meteorology must go to school to agriculture.

Favourable comment is made on the organization for the application of meteorological information to the requirements of agriculture in the U.S.A., and the author believes that a system of daily and special forecasts similar to that which exists in Great Britain would be of great value to Italian farmers, especially if Vercelli's method of forecasting for a period of days were employed. In southern Italy the annual crop losses due to weather and climatic conditions are particularly heavy. There most of the rain falls in autumn and winter; the summer is frequently a period of drought. Knowledge of the probabilities of fine or wet spells in the seed sowing season would enable the farmer to proceed in a way best calculated to ensure that the crops should offer the maximum resistance to possible summer drought. In this respect and in many others, such as the selection of varieties of crops best suited to local climatic conditions, proper cultural operations at critical periods of crop growth, and the conservation of the water supply for irrigation purposes, great assistance could be obtained from an agricultural-meteorological organization of sufficient scope, and correspondingly great gain would accrue to national economy.

"Money spent on agriculture is as the seed which is sown; the greater the outlay, the greater the return. Let the government not hesitate to spend on 'agrarian' meteorology the millions (lire) which have been expended on aeronautical meteorology. If aeronautics can make Italy powerful, agriculture can make her wealthy!"

H. W. L. A.

The Probable Solution of the Climatic Problem in Geology. By Wilhelm Ramsay (Washington, Ann. Rep. Smithson. Inst., 1924, pp. 237-248).

This paper discusses qualitatively the way in which extensive mountain formation causes a general cooling of the earth's surface especially by the increase in the rain and snowfall and ultimately by the formation of extensive ice sheets. The author concludes that changes in the general relief are the main cause of geological changes of climate.

Obituary

Mr. William Stephens Clark. Mr. Clark whose death occurred at Street, Somerset, on November 20th, had the distinction of being the senior among the 5,000 observers reporting rainfall observations to the Meteorological Office. He was born at Street in 1839, and educated at the Friends' Schools at Sidcot and York and at St. Thomas's Hospital. In 1866 he married Helen Priestman, eldest daughter of the Right Hon. John Bright. Fully occupied though he was through most of his long life as head of a large and constantly growing manufacturing business, to which was added active participation in district and county

duties, especially education work, temperance and social and political reforms, he sustained in full his interest in meteorological observations. These he inaugurated in 1857, and maintained continuously until his death. His observations appeared regularly in the volumes of *English Rainfall* and its successor *British Rainfall* from 1860 to 1924, a truly remarkable record. So far as is known there only remains one survivor, Mr. J. G. Wood, of that little band of pioneers who contributed their rainfall observations to the late G. J. Symons for his earliest work. Mr. Clark was a J.P. for Somerset and one of the original County Aldermen. He promoted the establishment of technical, secondary and day continuation schools in Street, and endowed a scheme of bursaries to assist children in obtaining education beyond that of the elementary schools. A photograph and short note appeared in this magazine for April, 1924, p. 49 and p. 67.

News in Brief

The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1926 to Lt.-Col. E. Gold, D.S.O., F.R.S., assistant director of the Meteorological Office, in recognition of his services to meteorology.

We learn from *Nature* that Professor W. H. Hobbs' expedition, to Greenland to establish a meteorological observatory there on the inland ice at an altitude of 6,000 to 7,000 feet some 150 miles from the west coast, will leave the United States in July next year. A station will be maintained there for a year and the observations will be transmitted daily by wireless to the United States and Europe. It is hoped that this service will be of great value in forecasting. Besides the ordinary observations, an investigation of the upper atmosphere will be undertaken.

Mr. F. N. Ellis, of Debdale Hall, Mansfield, reports that while a heavy snowstorm was at its height at about 7h. 20m. on November 27th, there were 5 flashes of lightning all within a mile of the house. The storm lasted from 7h. to 9h. when the day became fine and clear but very cold.

Books Received

Rechentafeln zur Harmonischen Analyse. By Dr. Leo. W. Pollak, pp. 20 (Leipzig, J. A. Barth).

Deutsches Meteorologisches Jahrbuch für 1924. Edited by Prof. Dr. Grosse, pp. 68 (Bremen Vereinigte Druckereien Jlling and Lüken), 1925.

Royal Botanic Society of London. Quarterly summary and meteorological readings, No. 26, October, 1925, pp. 15, illus. (London), 3d.

The Weather of November, 1925

Throughout the greater part of November fair dry cold weather prevailed over the British Isles. The month opened with mild unsettled conditions, rainfall measurements of over 25 mm. occurring at several places in the south and west, *e.g.*, 47 mm. (1·86 in.) fell at Llyn Fawr (Glamorgan) on the 1st, and 48 mm. (1·88 in.) at Holne, Devon, on the 2nd. Owing to a heavy rainstorm on the 2nd the Dolgarrog reservoir in North Wales burst and the surrounding country was flooded. During these days temperature rose in several instances to 60° F. or slightly higher. After that there was an appreciable fall which began first in Scotland and northeastern England, the maximum readings at Balmoral on the 6th and 7th being as low as 38° F. On the 7th a trough of low pressure extending eastwards from a large depression over the Atlantic caused gales in the English Channel and the Irish Sea, and much rain occurred generally in England and Ireland on the 6th, 7th and 8th, 50 mm. (1·97 in.) being recorded at Snowden (Carmarthen) on the 8th. As this trough moved southeast cold northeasterly winds backing north spread over England, and snow or sleet showers which had been experienced earlier in Scotland fell in the southeastern counties on the 9th and 10th. For the next day or two the weather was anticyclonic for the most part but between the 12th and 15th the western districts came under the influence of depressions over Iceland and the Atlantic and there was much rain or drizzle with occasional strong south winds. Subsequently anticyclonic conditions prevailed over the whole kingdom and fog occurred in many places, notably in north England and Scotland, where it persisted for many days at a stretch. By the 22nd conditions began to change and northerly winds spread over the British Isles. These strengthened during the next few days and attained gale force locally on the eastern coasts on the 25th, when a depression deepened considerably over the North Sea. The cold became much more intense and snow fell in most places; "snow-lying" to a depth of 6, 7 and 10 in. being recorded at Hull, Norwich and Scarborough on the 28th. Many low temperatures occurred during the month, screen minima falling below 20° F. in a few places, and grass minima below 15° F. The lowest grass minimum reported was 9° F., which occurred at Leuchars (Fife) on the 10th, and at Renfrew on the 26th. The total sunshine for the month was considerably in excess of the normal and the rainfall was generally below normal except on the east and southeast coasts of England. Scarborough had as much as 197 per cent. of the normal, while in Scotland, Stronvar (Perth) had only 9 per cent.

Pressure was above normal over the North Atlantic, Iceland and the northwestern coasts of Europe, and below normal over

southern and central Europe, including France and the Azores and also Denmark and southeastern Sweden, the excess being as much as 6 mb. in Iceland and the deficit 4·9 mb. at Rome. This distribution favoured northeasterly winds over the British Isles. Temperature and rainfall were generally below normal over western Europe though in the extreme north of Scandinavia the rainfall was above normal. At Spitsbergen the temperature was 5° F. above normal and rainfall 18 mm. above normal. During the first days of the month severe gales occurred on the North Atlantic, force 10 (59 m.p.h.) being reported by several liners. Many ships were damaged. About the middle of the month there were heavy falls of snow in Switzerland, central France and the land of the Slovenes. Owing to the heavy precipitation the rivers Save and Drina overflowed their banks and caused some loss of life and much material damage. Later in the month many heavy snowfalls occurred over the whole of central Europe, including Denmark and France, and the weather continued intensely cold until the end. In many places the telegraphic wires were broken and train and tramcar services dislocated owing to the snow. Gales were experienced along the coasts of southern Italy and Sicily on the 28th and 29th and caused considerable damage.

Following heavy rains throughout Iraq the Basra-Baghdad train was derailed 80 miles south of Baghdad, but owing to these heavy early rains the 1926 harvest in Iraq is expected to be prosperous. Heavy rain occurred in Morocco and on the evening of the 28th a storm swept over the valley of the Wergha and the region of Fez, during which 3 men were killed and about 20 injured.

Heavy rains fell on the 29th and 30th at Miami in Florida, flooding the streets.

The rainfall of Australia was generally above normal except in New South Wales where the deficit amounted to over 5 in. along the north coast.

The special message from Brazil states that the rainfall in the northern districts was scanty being 8 mm. below normal, in the central districts the distribution was irregular but the total was 14 mm. above normal, and in the southern districts it was plentiful with 94 mm. above normal. Fewer anticyclones passed across the country than in the previous month. The crops generally were doing well. At Rio de Janeiro pressure was 1 mb. above normal and temperature almost normal.

Rainfall November, 1925—General Distribution

England and Wales ..	88	per cent. of the average 1881-1915.
Scotland	45	
Ireland	69	
British Isles	73	

Rainfall: November, 1925: England and Wales

CO.	STATION.	In.	mm.	Per-cent. of Av.
Lond.	Camden Square	1·54	39	65
Sur.	Reigate, Hartswood	3·07	78	106
Kent.	Tenterden, Ashenden	3·10	79	103
,,	Folkestone, Boro. San.	4·27	108	...
,,	Broadstairs, St. Peter's	...	..	...
,,	Sevenoaks, Speldhurst.	3·13	79	...
Sus.	Patching Farm	2·91	74	82
,,	Brighton, Old Steyne	3·66	93	116
,,	Tottingworth Park	4·16	106	112
Hants	Ventnor, Roy. Nat. Hos.	4·26	108	133
,,	Fordingbridge, Oaklnds	3·02	77	88
,,	Ovington Rectory	3·05	77	92
,,	Sherborne St. John Rec.	2·10	53	74
Berks	Wellington College	1·85	47	72
,,	Newbury, Greenham	2·18	55	78
Herts.	Benington House	1·73	44	73
Bucks	High Wycombe	2·43	62	98
Oxf.	Oxford, Mag. College	1·77	45	80
Nor.	Pitsford, Sedgebrook	1·61	41	73
,,	Eye, Northolm	1·48	38	...
Beds.	Woburn, Crawley Mill	1·50	38	66
Cam.	Cambridge, Bot. Gdns.	1·28	33	66
Essex	Chelmsford, County Lab	...	..	...
,,	Lexden, Hill House	1·53	39	...
Suff.	Hawkedon Rectory	2·37	60	104
,,	Haughley House	2·31	59	...
Norf.	Beccles, Geldeston	3·24	82	139
,,	Norwich, Eaton	3·72	95	145
,,	Blakeney	3·19	81	144
,,	Swaffham	2·28	58	94
Wilts.	Devizes, Highclere	2·24	57	84
,,	Bishops Cannings	2·24	57	78
Dor.	Evershot, Melbury Ho.	3·49	89	82
,,	Weymouth, Westham	2·95	75	95
,,	Shaftesbury, Abbey Ho.	1·91	49	59
Devon	Plymouth, The Hoe	3·08	78	85
,,	Polapit Tamar	4·79	122	113
,,	Ashburton, Druid Ho.	5·27	134	93
,,	Cullompton	2·96	75	86
,,	Sidmouth, Sidmount	2·48	63	79
,,	Filleigh, Castle Hill	3·85	98	...
,,	Barnstaple, N. Dev. Ath.	3·70	94	94
Corn.	Redruth, Trewirgie	4·38	111	90
,,	Penzance, Morrab Gdn.	2·87	73	63
,,	St. Austell, Trevarna	6·06	154	123
Soms	Chewton Mendip	3·33	85	78
,,	Street, Hind Hayes	2·11	54	...
Glos.	Clifton College	1·80	46	57
,,	Rendcomb College	...	..	...
Here.	Ross, Birchlea	1·46	37	58
,,	Ledbury, Underdown.	1·52	39	62
Salop	Church Stretton	2·38	61	81
,,	Shifnal, Hatton Grange	1·62	41	68
Staff.	Tean, The Heath Ho.	2·00	51	68
Worc.	Ombersley, Holt Lock.	1·41	36	62
,,	Blockley, Upton Wold.	1·56	40	53
War.	Farnborough	1·86	47	68
War.	Birminghm, Edgbaston	1·64	42	69
Leics	Thornton Reservoir	1·81	46	80
,,	Belvoir Castle	1·78	45	80
Rut	Ridlington	1·79	45	...
Linc.	Boston, Skirbeck	2·22	56	111
,,	Lincoln, Sessions House	2·50	63	133
,,	Skegness, Estate Office.	3·20	81	148
,,	Louth, Westgate	2·59	66	120
,,	Brigg	2·40	61	105
Notts.	Worksop, Hodsock	2·02	51	103
Derby	Mickleover, Clyde Ho.	1·89	48	85
,,	Buxton, Devon. Hos.	3·00	76	64
Ches.	Runcorn, Weston Pt.	3·04	77	110
,,	Nantwich, Dorfold Hall	2·24	57	...
Lancs	Manchester, Whit. Pk.	2·81	71	106
,,	Stonyhurst College	2·51	64	56
,,	Southport, Hesketh	3·02	77	96
,,	Lancaster, Strathspey.	2·45	62	...
Yorks	Sedbergh, Akay	2·63	67	51
,,	Wath-upon-Dearne	1·62	41	79
,,	Bradford, Lister Pk.	2·37	60	81
,,	Wetherby, Ribston H.	1·71	43	73
,,	Hull, Pearson Park	2·76	70	126
,,	Holme-on-Spalding	2·15	55	...
,,	West Witton, Ivy Ho.	...	..	...
,,	Felixkirk, Mt. St. John	2·72	69	111
,,	Pickering, Hungate	3·25	83	...
,,	Scarborough	4·87	124	197
,,	Middlesbrough	2·74	70	129
,,	Baldersdale, Hury Res.	1·85	47	48
Durh.	Ushaw College	2·89	73	114
Nor.	Newcastle, Town Moor.	2·63	67	109
,,	Bellingham, Highgreen	1·58	40	...
,,	Lilburn Tower Gdns.	3·49	89	...
Cumb	Geltsdale	1·64	42	...
,,	Carlisle, Scaleby Hall	1·25	32	42
,,	Seathwaite M.	4·70	119	35
Glam.	Cardiff, Ely P. Stn.	2·68	68	64
,,	Treherbert, Tynywaun	4·91	125	...
Carm	Carmarthen Friary	4·29	109	86
,,	Llanwrda, Dolaucothy.	4·69	119	79
Pemb	Haverfordwest, School	4·74	120	94
Card.	Gogerddan	2·15	55	46
,,	Cardigan, County Sch.	3·93	100	...
Brec.	Crickhowell, Talymaes	2·65	67	...
Rad.	Birm. W. W. Tyrmynydd	4·52	115	68
Mont.	Lake Vyrnwy	3·38	86	61
Denb.	Llangynhafal	4·08	104	...
Mer.	Dolgelly, Bryntirion	4·45	113	72
Carn.	Llandudno	3·11	79	101
,,	Snowdon, L. Llydaw 9	8·97	228	...
Ang.	Holyhead, Salt Island.	2·74	69	66
,,	Lligwy	2·35	60	...
Isle of Man				
	Douglas, Boro' Cem.	2·88	73	60
Guernsey				
	St. Peter P't, Grange Rd	...	..	...

Rainfall: November, 1925: Scotland and Ireland

CO.	STATION	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	2·57	65	65	*Suth.*	Loch More, Achfary	4·89	124	57
,, .	Pt. William, Monreith	2·47	63	...	*Caith*	Wick	1·87	48	60
Kirk.	Carsphairn, Shiel.	2·47	63	...	*Ork.*	Pomona, Deerness	2·25	57	57
,, .	Dumfries, Cargen	2·08	53	46	*Shet.*	Lerwick	2·42	61	57
Dum	Drumlanrig	1·81	46	43					
Roxb	Branxholme	1·56	40	47	*Cork.*	Caheragh Rectory	2·75	70	...
Selk.	Ettrick Manse	2·21	56	...	,, ..	Dunmanway Rectory	3·66	93	59
Berk.	Marchmont House	2·16	55	72	,, ..	Ballinacurra	1·78	45	44
Hadd	North Berwick Res.	·92	23	41	,, ..	Glanmire, Lota Lo.	2·56	65	60
Midl	Edinburgh, Roy. Obs.	·81	20	37	*Kerry*	Valencia Obsy.	...	...	...
Lan.	Biggar	1·37	35	48	,, .	Gearahameen	4·50	114	...
Ayr.	Kilmarnock, Agric. C.	2·19	55	58	,, .	Killarney Asylum	2·88	73	51
,, .	Girvan, Pinmore	2·39	61	45	,, .	Darrynane Abbey	2·80	71	55
Renf.	Glasgow, Queen's Pk.	·91	23	24	*Wat.*	Waterford, Brook Lo.	2·47	63	65
,, .	Greenock, Prospect H.	1·46	37	22	*Tip.*	Nenagh, Cas. Lough	2·65	67	66
Bute.	Rothesay, Ardencraig	1·52	39	30	,, .	Tipperary	2·09	53	...
,, .	Dougarie Lodge	2·31	59	...	,, .	Cashel, Ballinamona	1·78	45	51
Arg.	Ardgour House	2·28	58	...	*Lim.*	Foynes, Coolnanes	2·48	63	62
,, .	Manse of Glenorchy	1·56	40	...	,, .	Castleconnell Rec.	2·43	62	...
,, .	Oban	2·03	52	...	*Clare*	Inagh, Mount Callan	3·86	98	...
,, .	Poltalloch	1·96	50	35	,, .	Broadford, Hurdlest'n.	2·85	72	...
,, .	Inveraray Castle	2·17	55	26	*Wexf*	Newtownbarry	2·89	73	...
,, .	Islay, Eallabus	3·54	90	66	,, .	Gorey, Courtown Ho.	3·83	97	110
,, .	Mull, Benmore	...	..	...	*Kilk.*	Kilkenny Castle	1·81	46	59
Kinr.	Loch Leven Sluice	·94	24	26	*Wic.*	Rathnew, Clonmannon	4·29	109	...
Perth	Loch Dhu	1·70	43	20	*Carl.*	Hacketstown Rectory	3·07	78	79
,, ..	Balquhidder, Stronvar.	·72	18	9	*QCo.*	Blandsfort House	...	..	...
,, ..	Crieff, Strathearn Hyd.	·75	19	17	,,	Mountmellick	...	..	...
,, ..	Blair Castle Gardens	·72	18	21	*KCo.*	Birr Castle	2·14	54	69
,, .	Coupar Angus School	·88	22	32	*Dubl.*	Dublin, FitzWm. Sq.	3·37	86	126
Forf.	Dundee, E. Necropolis	·88	22	36	,, .	Balbriggan, Ardgillan	1·95	49	68
,, .	Pearsie House	1·26	32	...	*Me'th*	Drogheda, Mornington	1·77	45	...
,, .	Montrose, Sunnyside	1·19	30	45	,, .	Kells, Headfort	1·99	51	59
Aber.	Braemar, Bank	2·01	51	52	*W.M*	Mullingar, Belvedere	2·36	60	69
,, .	Logie Coldstone Sch.	1·43	36	47	*Long*	Castle Forbes Gdns.	3·07	78	85
,, .	Aberdeen, King's Coll.	1·90	48	64	*Gal.*	Ballynahinch Castle	4·33	110	72
,, .	Fyvie Castle	2·81	71	...	*Mayo*	Mallaranny	5·10	130	...
Mor.	Gordon Castle	1·82	46	63	,, .	Westport House	3·86	98	79
,,	Grantown-on-Spey	1·59	40	53	,, .	Delphi Lodge	5·82	148	...
Na	Nairn, Delnies	·68	17	29	*Sligo*	Markree Obsy.	3·59	91	85
Inv.	Ben Alder Lodge	1·11	28	...	*Cav'n*	Belturbet, Cloverhill	2·07	53	67
,, .	Kingussie, The Birches	·91	23	...	*Ferm*	Enniskillen, Portora	1·85	47	...
,, .	Loch Quoich, Loan	...	..	...	*Arm.*	Armagh Obsy.	1·57	40	55
,, .	Glenquoich	...	..	...	*Down*	Warrenpoint	2·46	63	...
,, .	Inverness, Culduthel R.	·79	20	...	,, .	Seaforde	3·02	77	80
,, .	Arisaig, Faire-na-Squir	1·89	48	...	,, .	Donaghadee, C. Stn.	1·51	38	50
,, .	Fort William	2·13	54	26	,, .	Banbridge, Milltown	1·94	49	71
,, .	Skye, Dunvegan	5·76	146	...	*Antr.*	Belfast, Cavehill Rd.	2·10	53	...
,, .	Barra, Castlebay	...	..	...	,, .	Glenarm Castle	2·64	67	...
R&C	Alness, Ardross Cas.	1·77	45	44	,, .	Ballymena, Harryville	2·69	68	66
,, .	Ullapool	2·87	73	...	*Lon.*	Londonderry, Creggan	3·06	78	75
,, .	Torridon, Bendamph	4·13	105	45	*Tyr.*	Donaghmore	2·17	55	...
,, .	Achnashellach	3·21	82	...	,, .	Omagh, Edenfel	...	..	...
,, .	Stornoway	4·34	110	74	*Don.*	Malin Head	2·06	52	63
Suth.	Lairg	...	..	...	,, .	Rathmullen	2·98	76	...
,, .	Tongue Manse	3·22	82	70	,, .	Dunfanaghy	3·17	81	67
,, .	Melvich School	3·22	82	80	,, .	Killybegs, Rockmount	...	..	...

Climatological Table for the British Empire, June, 1925

STATIONS	PRESSURE Mean of Day M.S.L. mb.	PRESSURE Diff. from Normal mb.	TEMPERATURE Absolute Max. °F.	TEMPERATURE Absolute Min. °F.	TEMPERATURE Mean Values Max. °F.	TEMPERATURE Mean Values Min. °F.	TEMPERATURE Mean Values ½ max. and min. °F.	TEMPERATURE Mean Values Diff. from Normal °F.	TEMPERATURE Mean Wet Bulb. °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Am'nt mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible.
London, Kew Obsy.	1020·4	+ 3·7	84	44	70·5	51·4	60·9	+ 1·7	52·3	77	4·4	1	− 54	1	9·0	55
Gibraltar	1015·2	− 2·2	83	53	74·5	61·6	68·1	− 2·4	60·6	82	6·0	37	+ 25	4	...	...
Malta	1013·8	− 1·8	89	64	78·2	67·5	72·9	+ 0·2	65·3	67	1·8	1	− 1	1	9·7	67
Sierra Leone	1012·6	− 0·1	92	68	86·3	72·5	79·4	− 1·1	75·0	81	6·5	416	− 74	23	...	...
Lagos, Nigeria	1010·8	− 2·1	88	71	85·2	74·2	79·7	+ 1·1	75·4	86	9·3	518	+ 35	23	...	...
Kaduna, Nigeria	1013·4	− 0·4	93	...	85·4	...	...	...	71·2	84	2·4	295	+ 96	19	...	...
Zomba, Nyasaland	1016·3	− 1·3	87	48	76·1	53·1	64·6	+ 1·9	...	85	4·1	1	− 13	1	...	...
Salisbury, Rhodesia	1018·0	− 1·2	79	35	72·5	43·9	58·2	+ 1·8	52·3	60	1·3	0	− 1	0	9·7	87
Cape Town	1018·4	− 1·5	77	37	61·6	47·9	54·7	− 1·1	49·3	90	6·0	237	+128	17	...	...
Johannesburg	1022·3	− 1·2	68	28	59·5	39·0	49·3	− 1·4	38·7	53	1·1	2	− 1	1	9·4	90
Mauritius	1017·3	− 1·7	80	54	77·5	61·7	69·6	+ 0·2	67·6	74	3·2	53	− 18	12	7·9	72
Bloemfontein	...	...	67	22	59·1	29·6	44·3	− 3·3	35·5	83	2·8	0	− 12	0	...	...
Calcutta, Alipore Obsy.	999·7	0·0	101	75	92·2	79·2	85·7	+ 0·6	80·3	85	8·6	192	−110	15*	...	...
Bombay	1002·8	− 1·2	90	75	86·8	78·5	82·7	− 1·2	78·0	81	7·5	708	+203	20*	...	...
Madras	1003·9	+ 0·1	104	77	99·4	81·2	90·3	+ 0·2	75·8	55	5·7	6	− 42	1*	...	...
Colombo, Ceylon	1008·4	− 0·3	89	72	86·3	77·0	81·7	0·0	78·5	76	9·2	307	+111	25	4·6	37
Hong Kong	1005·4	− 0·7	91	72	85·6	77·6	81·6	+ 0·2	77·3	76	8·0	593	+184	19	6·6	49
Sandakan	...	...	92	72	88·7	75·2	81·9	+ 0·2	76·1	81	...	256	+ 71	13	...	...
Sydney	1022·3	+ 4·4	70	46	63·9	50·5	57·2	+ 2·5	52·4	80	6·0	152	+ 29	18	4·7	47
Melbourne	1024·2	+ 5·7	65	35	57·1	43·0	50·1	− 0·3	46·2	90	7·4	23	− 30	14	2·8	29
Adelaide	1024·0	+ 4·9	69	37	62·5	46·5	54·5	+ 1·1	49·5	76	5·6	59	− 19	11	5·2	54
Perth, W. Australia	1017·9	0·0	78	42	66·0	50·0	58·0	+ 1·2	52·1	75	6·8	216	+ 42	16	4·5	45
Coolgardie	1019·7	+ 0·6	76	36	66·1	44·5	55·3	+ 2·6	47·0	62	4·8	58	+ 27	7	...	...
Brisbane	1020·1	+ 1·9	76	41	69·2	51·4	60·3	0·0	54·3	74	3·9	186	+119	12	6·7	64
Hobart, Tasmania	1023·2	+ 8·9	63	32	52·5	40·8	46·7	− 0·1	41·9	83	5·7	61	+ 5	14	4·3	48
Wellington, N.Z.	1016·3	+ 2·0	62	32	52·8	42·6	47·7	− 1·8	45·2	83	7·7	212	+ 86	21	2·5	27
Suva, Fiji	1013·1	− 0·5	83	63	78·1	68·2	73·1	− 1·8	68·9	79	6·5	120	− 36	15	...	...
Apia, Samoa	1011·1	− 0·5	87	71	84·9	73·1	79·0	+ 1·2	75·6	75	4·0	75	− 56	12	8·5	75
Kingston, Jamaica	1013·9	+ 0·1	91	70	88·6	72·4	80·5	− 0·8	71·3	76	6·5	14	− 91	4	...	...
Grenada, W.I.	1014·5	+ 1·2	89	71	84·3	73·9	79·1	+ 0·3	75·0	77	7·3	204	− 15	25	...	...
Toronto	1013·7	− 0·6	95	42	77·2	56·3	66·7	+ 4·1	59·0	67	3·9	53	− 17	13	10.0	65
Winnipeg	1010·2	− 2·3	88	38	70·8	50·7	60·7	− 1·5	...	...	6·4	60	− 23	19	5·7	35
St. John, N.B.	1012·0	− 2·0	89	44	64·6	48·8	56·7	+ 0·2	52·2	77	7·0	127	+ 44	18	5·1	33
Victoria, B.C.	1016·5	− 0·4	95	45	65·5	49·9	57·7	+ 0·7	51·8	71	5·0	7	− 17	5	10·1	63

*For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

[illegible]	1016·5	− 0·4	95	45	65·5	49·9	57·7	+ 0·7	51·8	71	5·0	7	+ 44 − 17	18 5	5·1 10·1	33 63

*For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.